From Skin to Scale: Sensing Student Haptic Abilities
A Case Study on Clinical Breast Exams (2019)

Behavioral Multi-Scale Challenge (IMAG, *2009*)

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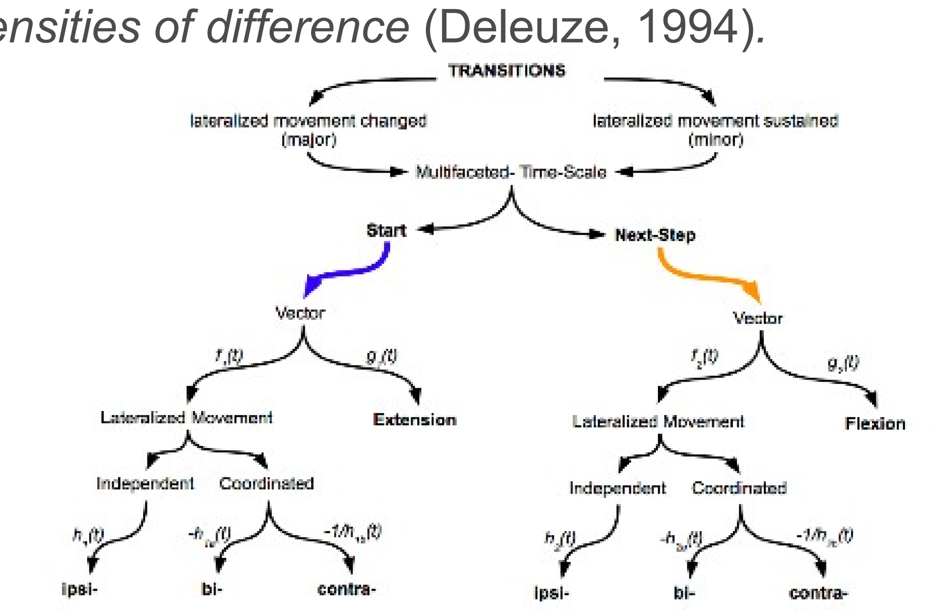
Argument

Direct biological interface navigates from skin to scale the *transparency* and *self-measurement* during sensorimotor transactions. Clinical beast exams serve as a testbed to determine translational techniques under natural conditions. ***Setting aside behavior as we know it there is the supply-side* view of behavior, that is, the manner each individual allocates their resources (*biological*) in time.** *Otherwise, models without high behavioral fidelity are less likely to expose the personalized biology each person brings under the skin. Already, at Microsoft Research Harrison et al.,* (2010) develop methods of direct biological appropriation hidden from the naked-eye during touching gestures. A wearable with *translational integration* proposes accuracy in movement recordings by indexing *preconditions* or *prerequisite* premotor cortical potentials (Dirnberger *et al.,*1998) An observation protocol will group pre-motor simulations and granular behavior markers. The following presents a paradigm of granular observations as a wearable *solution* to adjustments (neuroplasticity) during posture shifts. This case study addresses barriers and models to observe plausible pre-conditions and compute posture shifts as *intensities of difference* (Deleuze, 1994).

Table Anatomical Behavior Description Taxonomy in Intensity of Difference Series

Intensity (E-E')	*Behavior Markers (High Behavioral Resolution)*	*Time Markers (Behavioral Plasticity)*
E refers to... e – e'	*laterality* → (ipsi-, bi-, contra-) >	*transition* → t(from-, to-)>
	musculoskeletal → extension | flexion >	*repetition* → serial, cyclic>
	interlimb activity → independence | coordination >	*switching rate* → *en route*>
	geography touch fields → dorsal | ventral.	*perpetuation* →local time.
e refers to... ε – ε'	{(*ipsi-, bi-, contra-*)} → {(from- | to-)	*t(from-, to-)* → fractional series
	{*extension* | *flexion* } → sensorimotor transfer	*serial, cyclic* → excited | inhibit
	independence | coordination → backward |forward	*en route* → multi-function
	{ *dorsal* | *ventral* } → geography touch receptors	*local time* → flow patterns



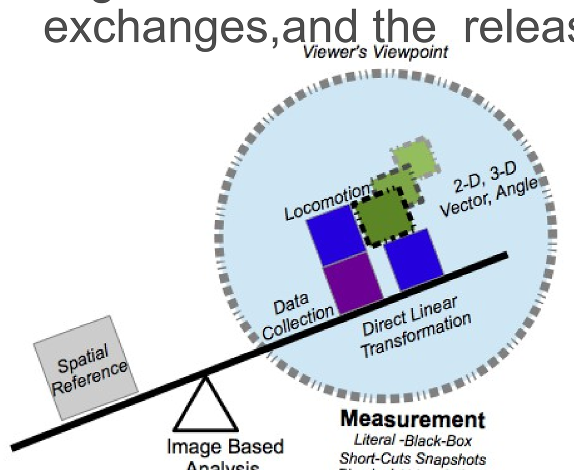
E → e, e → ε, ε → ε' trace hidden scales (excitatory/inhibitory exchanges). Otherwise cinematic recording produce a puppetry unable to index expert knowledge & performance (laterality: ipsi-, bi-, contra-).

Wearable behavioral research attempts to authenticate the translation of motor circuits' neuroplasticity by minimizing *biological uncertainty* and maximizing *behavioral assessments*. The multiscale capture of biologically principled inputs investigates levels of neurophysiology hidden from image-based capture. Posture shifts serve as behavioral markers to trace cellular signals in a time-domain. A direct biological interface is overdue to counteract observations of sensorimotor behaviors in a black-box.

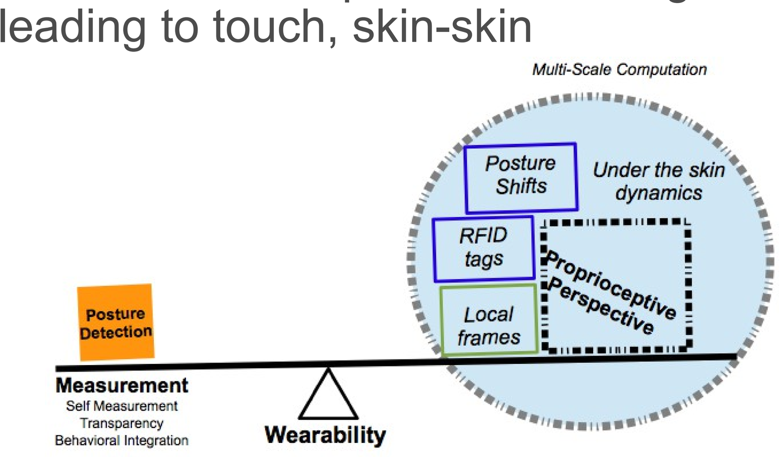
Background

Since Edward Muybridge's (1830-1904) study:"If all feet leave the ground during a horse's gallop?" motion assessment remains: (1) ***biologically neutral*** (a spatial measure based on cinematic recordings with frame-by-frame expressions); (2) ***anatomically skewed*** without the first-person perspective (over the shoulder) of proprioception; and, (3) *kinematics computation without state variables* what Kelso (2012) refers to as multistability.

A clinical breast exam offers conditions to examine the cohesion in multiscale computation. Photographic representations of biological movement are coarse temporal representations without indexing granularity in movement: independence/coordinated movement, sequential unfolding aligned with skin innervation or movement-touch pathways (leading to touch, skin-skin exchanges,and the release from touch).



Beyond the believability of the camera one finds the movement of the rock and an infant's movement require distinct assessment. RFID capture replaces direct linear transformation of 3-D experience into 2-D photographic data (Abdel-Aziz & Karara, 1971).



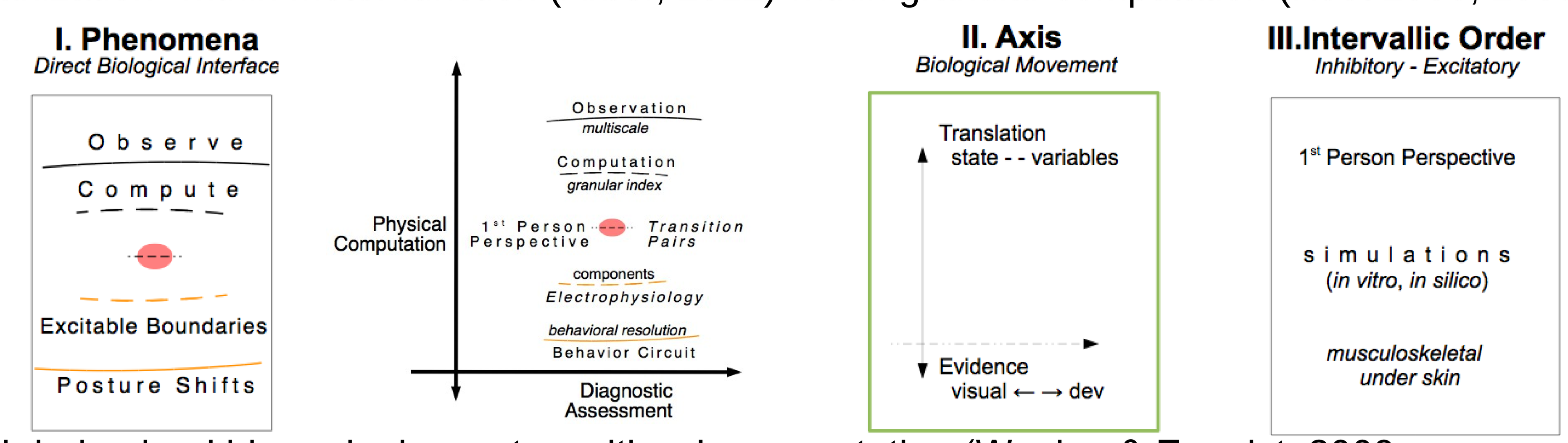
The diagnostic screening by medical students' haptic abilities signal movement analysis across biological criteria (Table 1) according to three strategies: (1) sensor guided training based user patterns (search, palpitation, and manual maneuvering) (Kotranza *et al.*2009); (2) combination of mammography tools & variation in breast mass (Kolb *et al.,* 2002); (3) proprioception (Khoshhal *et al.*, 2010) first person-perspective. Each medical practitioner exercises anatomical knowledge. Further study would reconcile sensorimotor units, equilibrium in the body, and ancillary movements.

Table 1 Systematic Reading of Visual Evidence

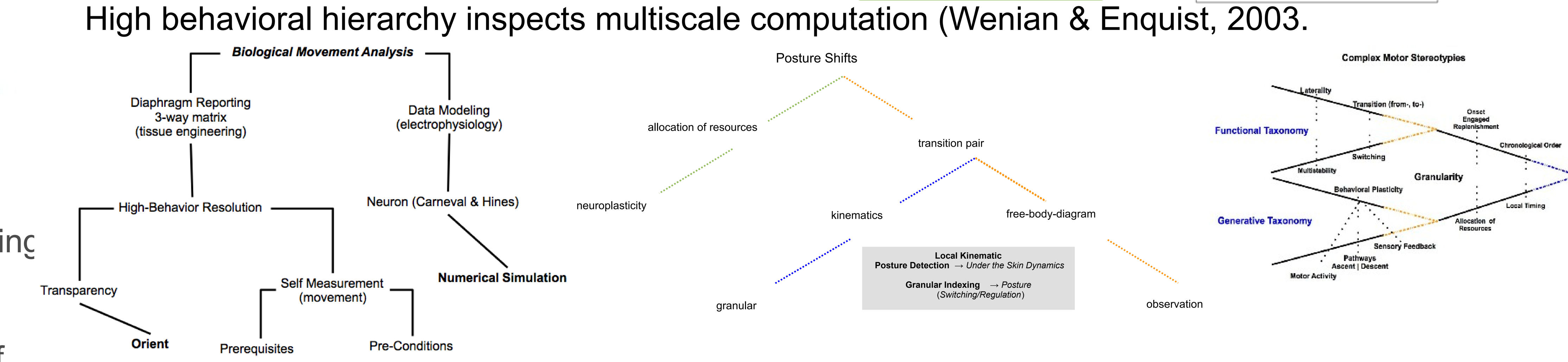
Categories	*Touch Sensing* (Kotranza *et al.*, 2009)	*Imaging & Physical Exam* (Kolb et al., 2002)	*Laban Analysis* (Khoshhal *et al.*, 2010)	*Wearability* (Bobbitt, 2019-23)
Summary				
	Haptic screening based on the patient's contour.	Mammographic findings **calcified** and/or **deformed** the normal breast architecture, detectable (*fatty* and *dense* breasts)	Proprioceptive application without a neurobiological approximation in the tool design	Proprioceptive application while monitoring posture shifts within narrow shifts during localized movements.
	Unmeasured the practitioner's haptic ability.			
	Unknown the **patient-practitioner biological interface**	**Noncalcified** and **nondeforming**, theorized dificult to detect in *dense breasts*.		
Data Collection				
Boundaries & Classifiers	Palpitation Pressure	1. breast: fatty/density categories	General Movement 1. Laban Movement Analysis	1. Localized histories of interlimb activity
	Gaussian Mixed Models (pressure low, medium, high, too high)	2. Non-palpitation (needle located)	2. Probabilistic Bayesian process feature extraction (Laban parameter Effort)	2. Backward/Forward movement (non-reciprocal)
	Palpitation Position Expectation-Maximization Model	3. Technique (mammography I ultrasound I physical exam)		3. Biological indexing of movement (dorsal/ventral; anterior/posterior.
Targeting	Pattern-of-Search	1. Screening position (fatty/density)	Power Spectrum (PS) feature extraction acceleration	1. Granular indexing (non-semantic) promotes multiscale computation
	Learner's search pattern same (e.g reverse order) as expert without copying expert trajectory	2. Positioning-imaging (common breast contralateral posterior oblique;large breast ipsilateral posterior oblique)	1.3D data collection wearable suit 1st person detection	2. Allocation of resources in biological movement
	Angle matching learner & expert	3. PE spoke-search palpitation; erect and supine positions, palpation entire breast in the supine position (upright for women with small fatty breasts), patient arms turned contra- and ipsilateral oblique	2. Classify Laban parameters acceleration Effort.time (head, right hand, left hand, right foot, left foot and centre of the body)	
			3. Acceleration Signals marked Sustained or Suddenly	
Quantitative Analysis				
Procedural Practices				
Engineering Standards				
Diagnostic Accuracy				

Materials

Research methods hover in same corner but wearability clarifies Feng *et al.'s* (2004) premise, photographic imaging lags as a capture system . There are preliminary steps to accomplish specialized goals for multiscale computation: (1) *reduction of visual acculturation* (removal of black-box observations & knowledge in favor of excitability in biological movement); (2) *scientific workflows specialize "what we see"* via translational methodology (a truer capture technology distinguishes backward movement and forward movement as the literature since Chalfie *et al.* (1985) suggests; and, (3) *granular indexing* (methodical measurement of lateral movement indicative of "interleaving layers of organization" within motor function (Arber, 2012) within granular computation (Keet 2006, 2008).



High behavioral hierarchy inspects multiscale computation (Wenian & Enquist, 2003.



Beyond the believability of the camera one finds the movement of the rock and an infant's movement require distinct assessment (*in vivo*, *in vitro*, *in silico*). A wearable interface will support a systematic analysis of posture shifts by observing transition pairs {(from- , evacuation) | (to-, entry)}. Such a wearable system aligns: (1) posture shifts (granular indexing), (2) local movement signatures (local positioning system); and, (3) simulations in NEURON (Hines & Carnevale, 1997) based upon neurophysiology data (Briggman & Kristan, 2008; Marder & Calabrese,1996).

Next-Steps

Key points underpin movement: (1) touch pinpoints articulated motion (a performer's expert knowledge & sensorimotor activity); (2) acts as a conduit for measurement (knowledge sets on excitability rather than locomotion); and, (3) reports on the eventuality of slow timescales (movement promotes early neural development).

The allocation of resources provides a foundation to observe, index, and compare movement (haptic & posture shifts) in the time domain. Posture shifts occur within a first person perspective shadowed by a wearable solution. The first person perspective as an agent to identify subtle transitions in posture shifts guided by multiscale observation.

TWO EXAMPLES of FIRST PERSON PERSPECTIVE

(left) Split screen illustrates the first person perspective (over the shoulder) in cinema from De Palma's movie Sisters (1973).

(right) autism scene-only scanning black lines in (a) & (b) typically developed viewer social-scanning white lines in (a) & (b).from Klin *et al.* (2003)

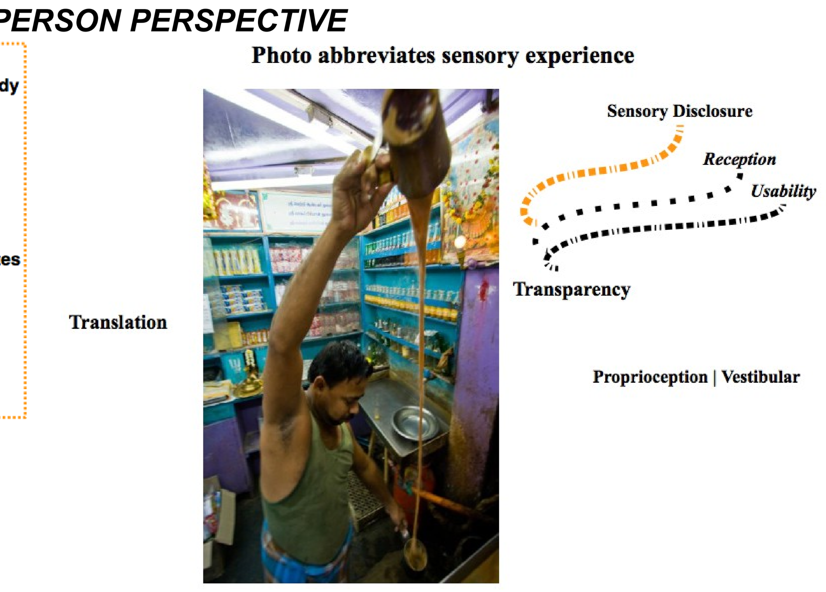
HOW TO TRANSLATE PHOTOGRAPHY INTO THE FIRST PERSON PERSPECTIVE

First person perspective diagrams sensorimotor engagement while your body manipulates objects.

Wearable Diagram Records:
(1) sensory feedback elevated hand;
(2) manual grasp;
(3) joints' articulated control;
(4) equilibrium or proprioception.

Any photo of long pull tea pouring abbreviates sensory experience.

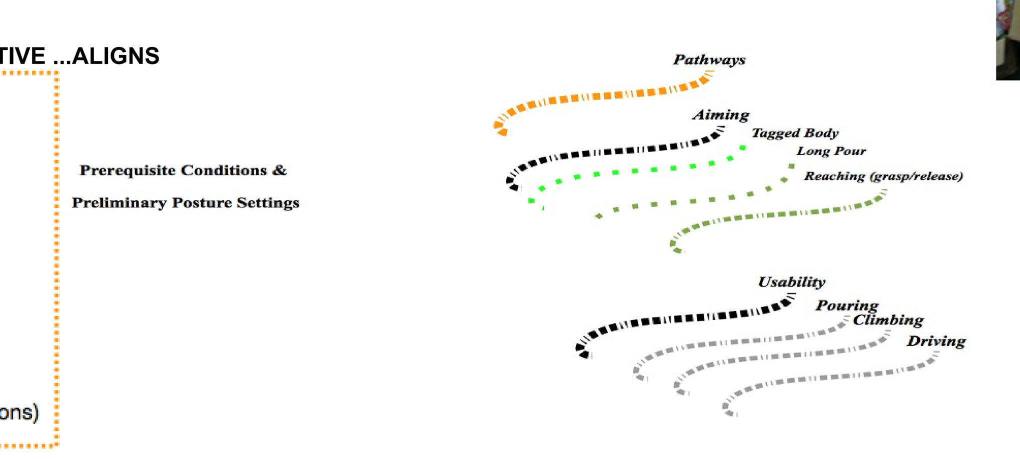
Removing the black-box & wearables recognizes sensory controls:
Graphics for Hidden Values (sensorimotor)
Proprioception I Vestibular
Musculoskeletal I Sensory Feedback



DIAGRAMMING A FIRST PERSON PERSPECTIVE ...ALIGNS

(1) overhead sensory feedback
(weight-bearing) tea pours (pot---cup);
(2) **lower equilibrium maintained**
the tea pour grasps a cup;
(3) **draws bio-mechanical patterns**
(lateral, extension/flexion, etc.)

Wearable interface measures:
(1) **prerequisite conditions**
(cellular mechanisms)
(2) **preliminary posture settings**
(posture shifts as transitions pairs:
(from-, evacuation) I (to-, entry)
(3) **traces** of past, present, & next steps (conditions)



Motion capture comparisons between individuals with distinct presentation requires a boundary system to index local optimality and personal time signatures. This study points toward a behavioral computational infrastructure, *built from the ground up.* Multi-scale computation in sensorimotor activity anticipates a translational observation of "what a person brings under the skin."